

The Effect of Cue-specific Lexical Competitors on Hyperarticulation of VOT and F0 Contrasts in Korean stops

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Standard Korean has an unusual three-way laryngeal distinction in stops: aspirated (e.g., /p^h/, ‘grass’), lenis (e.g., /pul/, ‘fire’), and fortis (e.g., /p*ul/, ‘horn’). VOT is historically a primary cue distinguishing these contrasts, with fundamental frequency (F0) of the following vowel as a secondary cue: in accentual phrase-initial positions, aspirated stops are associated with the longest VOT and higher F0 on the following vowel, lenis stops with an intermediate VOT value and lower F0, and fortis stops with the shortest VOT and higher F0 [1]. This work focuses on the aspirated~lenis contrast.

Many, particularly older, speakers of Seoul Korean produce both robust VOT and F0 distinctions between aspirated and lenis stops [2]. However for many speakers of Seoul Korean a transphonologization is in progress in which the VOT cue progresses toward neutralization between aspirated and lenis stops, with a concomitant expansion of the F0 contrast [2], leaving lexical contrasts intact. A variety of factors have been found to predict aspects of this sound change in progress. At the speaker level, lower age and female gender are associated with a more advanced position in this sound change [2], while at the lexical level, higher word frequency and lower following vowel are associated with more advanced position, that is, a smaller VOT and greater F0 contrast [3].

The potential role of lexical functional load in this sound change, however, has not yet been investigated. Theoretical models of speech production and perception within a community predict that phonemic contrasts will be relatively hyperarticulated when they carry more lexically disambiguating information, which over diachronic time can influence the trajectory of sound change [4]. In support of these models, a greater number minimal pairs (i.e., pairs of words distinguished by a single phonemic contrast) has been shown to be significantly correlated with preservation of that phonemic contrast over time [5]. At the level of individual speech production, contrastive hyperarticulation in minimal pairs has been found in English consonant VOT contrasts (e.g., ‘pat’~‘bat’) as well as in vowel formant contrasts (e.g., ‘lift’~‘left’) [6]. The same effect has also been found in Japanese singleton and geminate consonants (e.g., /kata/, ‘frame’~/katta/, ‘bought’) [7]. The ongoing sound change in Korean stops provides an opportunity to further explore the predicted connection between the lexicon, usage-level variation and systemic change in the sound system. Here, we use a production experiment to ask whether minimal pair status influences variation in production of VOT and F0 in aspirated versus lenis stops, and whether the degree of variation is influenced by a speaker's position in this sound change. Based on the previous body of theoretical and experimental work, we expect that both VOT and F0 will be hyperarticulated, but that speakers more advanced in the sound change may show greater hyperarticulation of F0 relative to VOT.

We identified minimal pairs of the same syntactic category distinguished by the aspirated~lenis stop contrast in word-initial position from the Korean National Database, as well as a set of aspirated/lenis stop-initial words balanced for following vowel that do not have minimal pair competitors. A total of 78 word sets were inserted into 220 meaningful, declarative sentences, controlling honorific degree. A shorter version was also made by removing 92 sentences from the set for elder speakers who had difficulty producing the larger set. Participants comprised 41 adult Seoul Korean speakers, 26 females and 15 males, born between 1932 and 1996. All but one female speaker and nine speakers who read the short list version produced all of 220 sentences, thereby totaling 7,703 utterances. VOT was hand-annotated, and F0 extracted using Praat's built in function. F0 was semitonized and normalized relative to the F0 of the vowel in the second syllable in the word to control for prosodic context. To identify a speakers' position within the sound change, we introduce a novel measure comparing the degree of use of the VOT contrast to the

degree of use of the F0 contrast. This measure was calculated over a speaker's set of non-minimal pair word productions as in Equation (1), where F is the difference between the median of the z-scored F0 values of a speaker's aspirated stops and that of their lenis stops in non-minimal pairs, and V is the corresponding difference in aspirated and lenis VOTs.

$$\text{Position} = F/(V + F) \quad (1)$$

Values of 'Position' for this set of speakers range from near 0.5, indicating that the speaker produces a balanced F0 and VOT contrast between aspirated and lenis stops, to near 1, indicating that the speaker produces solely an F0 distinction.

VOT and normalized F0 were separately modeled as a function of age, gender, lexical frequency, speech rate, vowel height, 'position', and presence of a minimal pair, using Bayesian hierarchical models fitted in Stan via the R package *brms*. Based on initial analysis of global models, we analyzed models with individual laryngeal class and vowel height levels fitted with the same syntax as that of the global models. Analysis shows that the aspirated~lenis contrast is significantly hyperarticulated in minimal pairs for both VOT and F0 cues, but only in aspirated stops with following high vowels. In addition, speakers advanced in the sound change produce significantly lower F0 values for lenis stops with following non-high vowels if there is an aspirated minimal pair competitor. These results extend our understanding lexical contrast-driven hyperarticulation by showing contrastive VOT and F0 hyperarticulation in minimal pairs in a language other than English. We find that the F0 distinction in lenis stops is relatively more hyperarticulated in speakers who are more advanced in the sound change consistent with predictions, but that speakers appear to hyperarticulate VOT regardless of how much of a VOT contrast they normally produce themselves. This may be related to the fact that VOT is still a robust cue to the aspirated~lenis distinction in much of the speech community - if so, this result is consistent with listener-oriented models of contrastive hyperarticulation [8].

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